Value Creation from Circular Economy led Closed Loop Supply Chains: A Case Study of Fast Moving Consumer Goods

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The role of closed loop supply chains (CLSC) for creating and recovering value is widely acknowledged in supply chain management and there are many examples, mainly in the business-to-business sector, of successful OEM remanufacturing. The integration of value creation and recovery activities into retail customer value propositions is, however, under researched and raises many challenges, especially in Fast Moving Consumer Goods (FMCG) retail where few real world examples have been published. The recent emergence of the term 'circular economy' has initiated further debate about closed loop value propositions and closed loop supply chain implications. This paper selects four circular economy-led closed loop product case examples from a major European FMCG company, and assesses, at a high level, how these cases created value, for whom value was created, and key challenges in their implementation. The findings highlight that each case is different. Closing loops and creating successful value propositions is complex and requires simultaneous reconfiguration of key building blocks to ensure customer acceptance and business viability. The paper proposes the term 'circular supply chain' for cases where circular economy principles are explicitly incorporated in CLSC for value creation.

Keywords: closed loop supply chain; circular economy; case study; value creation; circular supply chain; supply chain management

1. Introduction

In supply chains great strides have been made in recent years to reduce the material and resource intensity of production, products and wastage through resource efficiency (Daaboul, Le Duigou, Penciuc, & Eynard 2016; Genovese, Acquaye, Figueroa, & Koh 2015), and green and low carbon supply chains initiatives (Pan et al. 2015; Park, Sarkis, & Wu 2010; Zhu, Geng, & Lai 2010), although there is still a tendency to view environmental sustainability and economic performance as a trade-off (Colicchia, Creazza, Dallari, & Melacini 2016). The task of remaining competitive whilst creating social and environmental value through supply chain re-design therefore remains an on-going challenge.

There are different ways to frame and structure the discussion about value creation possibilities from the re-design of supply chains and structural leakages of product and materials arising from geographic dispersion and complex multi layered bills of materials and product complexity (Klassen 2009). One approach is closed loop supply chain (CLSC) design. Guide and Van Wassenhove (2009, p. 10) defined CLSC as ‘the design, control, and operation of a system to maximise value creation over the entire life cycle of a product with dynamic recovery of value from different types and volumes of returns over time’ and includes product return management, leasing and remanufacturing (Blackburn, Guide Jr, Souza, & van Wassenhove 2004; Hu, Li, Chen, & Wang 2014; Klassen 2009).

CLSC has attracted increasing academic and practitioner interest in recent years although how it works in practice – both in terms of value creation and materials loss of value across a supply chain - are often narrowly framed (Guide & Van Wassenhove 2006; Lehr, Thun, & Milling 2013; Rogers, Ronald & Rogers 2010; Schenkel, Caniëls, Krikke & van der Laan 2015). One major reason is that in production and manufacturing the complexity and proliferation of materials, often combining technical and biological materials alongside new additives, adhesives and multilayered packaging, creates numerous challenges to the recovery of value in reverse flows. These difficulties lead to problems such as separating products and materials, achieving sufficient scale and reliability of supply, and identifying materials and their quality and purity. They are therefore often disposed in landfill, or converted from waste to energy, or, recycled.

Alongside CLSC, the term circular economy (CE) has become increasingly prominent in recent academic literature (e.g.Bocken, de Pauw, Bakker, & van der Grinten, 2016; Ghisellini, Cialani, & Ulgiati, 2016). A formal definition of a circular economy as used in this paper is one that is 'restorative and regenerative by design, and aims to keep products, components, and materials at their highest utility and value at all times distinguishing between technical and biological cycles[1]'. It is an economy designed to preserve and enhance natural capital, optimise resource yields, and minimise system risks by managing finite stocks and renewable flows (Webster 2013, 2015).

As with CLSC, it is argued that to drive value and support industrial take-up CE business models and supply chains need to be more cost effective, deliver superior revenues or improve capital and resource productivity so as to beat the linear model (Hopkinson and Spicer 2013). The attraction to business of both CLSC and CE is that such activities offer a potentially better management of various forms of resource risk and future value creation. This then poses questions of how this might be achieved, how it works in practice, and what might it mean for supply chain or CLSC management. These questions form a key focus for this paper.

Both CLSC and CE offer the prospect of an integrated approach to generating economic, social and environmental value which then also intersects with other framings such as shared value (Porter & Kramer, 2011) and broader discussions around sustainable business models and whole system value (Barber, Beach, & Zolkiewski, 2012; Evans, Norell Bergendahl, Gregory, & Ryan, 2009). In this paper, we refer to this integration as circular supply chains. Common to each of these perspectives is an appreciation that value creation via closing of loops presents many strategic, operational

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[1] https://www.ellenmacarthurfoundation.org/circular-economy/overview/concept

and tactical challenges including: network design, collection strategies and decisions to lease or sell; tactical issues as acquisition of product returns, return dispositions; and operations issues as scheduling, routing etc. (Chouinard, Aït-Kadi, Van Wassenhove, & D'Amours, 2009; Souza, 2013). These challenges reinforce the observations by Barber et al. (2012, p. 106) that 'developing a sustainable business model is no trivial matter' and examples that have proven to be economically viable are limited.

Extant literature in CLSC relates to theoretical and manufacturing-specific OEM (original equipment manufacturer) product flows (Alghisi & Saccani, 2015; Rapaccini, 2015), with less attention paid to retail/consumer facing sectors (Genovese, Lenny Koh, Kumar, & Tripathi, 2014). Future research requirements include a need for more empirical studies, a better understanding of consumer responses to remanufactured goods, and the relationship between product design and recovery activities (Souza, 2013). To address these gaps, this paper focuses on a real world case study.

The case example, a major retailer in the fast moving consumer goods (FMCG) sector, is interesting firstly because such cases are rarely discussed. Secondly, because it is much closer to the point of sale and consumption to manufacturers and OEMs it offers different challenges when designing or configuring reverse flows. The management of CE inspired closed loop value propositions is examined through the lens of four different closed loop products and/or supply chains examples.

The aim of this paper is therefore to assess how and why the four examples created value, for whom, and to explore some of the key issues in the delivery of those new value propositions within the context of a multi-national FMCG.

The key questions this paper addresses are:

(1) How do CE led CLSC's create value?

(2) What are the key challenges that need to be addressed in implementing circular supply chains within a FMCG environment?

The paper is structured as follows. Section 2 reviews extant literature relating to value creation in CLSC and CE and some of the key building blocks and challenges of capturing this value. Section 3 includes brief descriptions of each case example and the methodology used in the research. Findings related to value creation and key issues are presented in section 4, followed by a discussion in section 5. The paper will conclude with broader lessons and future research for circular supply chains in section 6.

2. Value creation, CLSC and the Circular Economy

The traditional model of value creation in management theory and supply chain literature is normally based on one-directional flow of primary activities from raw material inputs, inbound logistics, outbound logistics, marketing, sales and to service (Porter, 1985). We refer to this model as a linear model. The focus of design and revenue generation is usually on the manufacturing and retail processes, and not on end of life stages where a public body is normally responsible for consumer waste collection where there is a natural incentive for lowest cost disposal options such as landfill or incineration.

Guide and Van Wassenhove (2006) define CLSC through three major activities: product return management, remanufacturing operational issues, and remanufactured products market development. Here attention is given to minimising cost (Govindan, Soleimani, & Kannan, 2015) with less focus on value creation (Abdallah, Diabat, & Simchi-Levi, 2012). Although there is an acknowledgement in the extant literature that a reverse logistics strategy could be a potential differentiator for higher customer satisfaction (Hofmann & Locker, 2009; Jayaraman & Luo, 2007; Loomba &

Nakashima, 2012; Wells & Seitz, 2005; Wu & Barnes, 2016), product acquisition, disposition, remanufacturing, cannibalisation of new sales and remarketing are still ongoing challenges (Guide & Van Wassenhove, 2009).

(Barber et al., 2012) have argued that the analysis process for CLSC is often fragmented, that it fails to integrate the forward and reverse supply chains or promote an integrated value cycle framework. To address fragmentation, Chouinard et al. (2009) elaborated a CLSC framework for the design and management of value loops highlighting key capabilities and organisational requirements in marketing, design, logistics and operations. Holimchayachotikul, Derrouiche, Damand, and Leksakul (2014) amongst others stressed the importance of collaboration, although observing that integrating value creation and recovery activities requires "overcome[ing] the old paradigm of competing as independent entities" (Hofmann & Locker, 2009, p. 79). The combination of value cycles and collaboration equates to Porter and Kramer's (2011, p. 52) concept of shared value achieved via reconceiving products and markets, redefining productivity in the value chain, and building supportive industry clusters at the company's locations.

More recently, Schenkel, Krikke, Caniels, and van der Laan (2015b) highlighted the lack of research into how different loops create value in practice, despite a growing interest in CLSC. Four types of value creation were identified by Schenkel, Krikke et al. (2015a): economic, environmental, information and consumer oriented. Two significant reports on the positive business and economic cases for a circular economy (EMF 2012, 2013) stimulated widespread interest in circular value creation potential leading to a number of academic and policy contributions into how this might be achieved (Bakker, Hollander, van Hinte, & Zijlstra, 2014; Ghisellini et al., 2016; Haas, Krausmann, Wiedenhofer, & Heinz, 2015; Lacy & Rutqvist, 2015; Lieder & Rashid, 2016), lending support to the views of Park et al. (2010) of the potential role of CE in value creation within supply chain management.

An important distinctive aspect of CE is that the conception of materials leakages and value creation loops can have very different meanings for technical and biological materials. For technical materials, including metals, plastics and glass leakage, they refer to the loss of materials, labour and energy in products and components that cannot be reused, refurbished or recycled within closed or continuing loops. The point at which products and materials are recovered has a significant bearing on the value creation possibilities. Recycling for example generally has lower value recovery than re-use or remanufacture (Guide Jr, 2000) and it has been suggested that recycling should not be considered as closed loop (McDonough & Braungart, 2013) .

Biological materials on the other hand are consumable and hence are not used in the same way as technical materials. Avoiding degradation, loss and degeneration of soils, ecosystem services and natural capital is therefore a key aspect of CE led closed loop practices. Leakage in a bio cycle refers to the loss of opportunity to maximize the cascaded use period and the inability to return the nutrients back into the soil due to contamination. (EMF, 2012).

It follows from this basic distinction and principles that opportunity for circular value creation can be analysed against four broad archetypes (EMF 2012, 2013) as stated below:

(1) Inner Value Creation Loop: Maintaining the integrity of a product at its highest level via service and maintenance (to preserve materials, labour, energy, capital for their original purpose)

(2) Extending Value Creation Loops: Using products and materials longer via product durability or design for remanufacturing and re-use (to enable repeat cycles)

(3) Cascading Value Creation Loops: Cascading use in adjacent value chains (where the costs of re-used products and materials are lower or have superior value compared to virgin or non-renewable materials) and

(4) Pure Value Creation loops: Creating pure, high quality feedstock at the outset (avoiding contamination and toxicity to allow for re-use and cost avoidance of clean up or purification).

The translation of these archetypes into specific business models can take many forms including performance and servitisation based models, product-service systems, and collaborative consumption (Bocken et al., 2016; EMF, 2012; Ghisellini et al., 2016). As an illustration the Rolls Royce Total Care Contract (power by the hour) is a famous example of a successful inner value creation loop (performance based business model) and extended value creation loop (via product life extension) underpinned by firm-customer incentives and shared benefits to continually innovate and improve performance (Smith, 2013).

Numerous challenges to closing loops within supply chains have been previously identified within the CLSC literature including the globalised nature of production processes and material flows (Wells & Seitz, 2005); target market identification and product design (Chouinard et al., 2009); designing a product recovery network (Abdallah et al., 2012); customer acceptance of remanufactured products (Zhu & Tian, 2016), and customer relationship management (Seitz & Peattie, 2004). Key enablers to overcome these challenges include proximity to end customers (Choi, Li, & Xu, 2013), incentives and coordination (Souza, 2013), and new business models (Barber et al., 2012). Choi et al. (2013) proposed that CLSC might perform better in a retail environment, although the incentives for retailers to manage reverse flows and networks of products is not straightforward and requires coordination between manufacturer and retailer, which might include sharing reverse revenue (Souza, 2013). Barber et al (2012) stressed the need for potential fundamental shifts in the business model from ownership to access (such as the Rolls Royce example above) and product service systems (Mont, 2002; Tukker, 2015) and/or servitisation.

Many of these key challenges and enablers identified in the CLSC literature also appear in recent debates about the circular economy, although much greater emphasis on, and one important reason for interest in, CE appears to have been a focus on how to create and unlock value rather than dwell on the challenges per se (see EMF 2012, 2013, 2017). Table 1 summarises from this practitioner focus the key capabilities around four key building blocks that have been proposed to be fundamental to deliver circular value creation – product design, business model innovation, reverse supply chain design and system enablers.

Table 1. Key challenges and building blocks of value creation from CE led closed loop (EMF 2012; EMF 2013)

Building block	**Capabilities and Configurable elements**
Circular Design	Capabilities for successful circular design include: material selection, standardised components, designed-to-last products, design for easy end-of-life sorting, separation or reuse of products and materials, and design-for-manufacturing criteria that take into account possible useful applications of by-products and wastes.

Business model Design	Capabilities for successful circular business model innovation include the ability to identify value creation, value capture and value distribution for any given business context and demonstrate the superior business benefit compared to a base linear case. There are a wide number of business model archetypes that can be used as a starting point e.g., service and performance based, incentivised return, value added services, etc.
Forward and reverse supply chain	Capabilities for cascades and the final return of materials to the biosphere or back into the industrial production system include excellent customer service and supply chain processes such as delivery chain logistics, sorting, warehousing, and risk management, to achieve cost-efficient, better-quality collection and treatment systems, and effective segmentation of end-of-life products,
System enablers	Capabilities for identifying, anticipating and harnessing key enablers include new forms of partnerships and collaboration across the value chain, digital transformation, rethinking internal incentives, working with regulators and policy makers, having access to finance, building on existing systems and organisational characteristics

To conclude this section, it is evident that the term 'closed loop supply chain' is extremely broad, refers to a wide range of potentially different value activities and raises many challenges. The focus of much of the CLSC literature has tended to be around manufacturing, product return management and cost control with limited focus on fast moving consumer goods, retailers, biological materials or broader societal and environmental value creation. An overly narrow definition of closed loop such as PRM or product refurbishment, whilst potentially producing some eco or resource efficiency savings, could “overwhelm resource savings with even larger growth in the production of the wrong products, produced by the wrong processes, from the wrong materials, in the wrong places, at the wrong scale, and delivered using the wrong business models (Hawken, Lovins, & Lovins, 2000).

The circular economy is a perspective with the explicit goal of regenerating natural, social and economic capital in part by cycling or cascading products, parts and materials at their highest value for the longest time via a clear set of building blocks and capabilities Some of the underlying conceptual and operating principles of value creation in CE reflect aspects of previous discussions by, amongst others, (Barber et al., 2012; Evans et al., 2009; Nemoto, Akasaka, & Shimomura, 2015; Schenkel, Caniëls, et al., 2015) hence offering the prospect of adding further insights to CLSC research and practice. This leads us next to how to analyse and assess how it works in practice.

3. Methodology

This paper adopts a case study approach (Yin 2003) based on four examples of contemporary closed loop products within the context of a real life home improvement company with over 1,100 stores in 10 countries across Europe employing around 74,000 people. These four cases were selected to highlight the challenges of managing different value loops. (Pokharel & Mutha, 2009) identified case study research as an important research direction in CLSC and it is regarded as one of the most powerful research approaches in operations management (Voss, Tsikriktsis, & Frohlich, 2002). The four cases in this paper explore why these examples were identified as closed-loop value propositions and how they were delivered and the outcomes. For these types of how and why questions, Yin (2003) stated that case studies are especially useful.

3.1 Context

The case company retails around 400,000 products (also known as store keeping units – SKUs) across its top five operating companies of which around 7,000 are sold by more than one operating company. In 2015, the group sourced from 2,167 critical suppliers including 1,028 factories and 1,139 suppliers of own and exclusive brand products.

In 2013, it published its vision for a circular economy (Kingfisher, 2013), known as Net positive, based around closed loop innovation and the company selling products where 'nothing is wasted'. This was a bold statement for a company based on a successful linear retail model. The stated basis for this vision was, 'if done well, closed loop innovation can cushion our business from price volatility, provide us with competitive advantage [ ] to close the loop, we must think differently – right from the initial design phase through the entire manufacturing process.

The company has an ambition to create 1,000 closed loop products and 10 closed loop supply chains by 2020. This programme provided a unique opportunity to examine a number of real world case examples within one organizational context. Proposals/nominations for which products or supply chains to put forward for closed loop design and re-design are made by individual teams within the case company and its operating companies.

3.2 Case Study Description

For our case examples, we chose one kitchen, one tool and two garden products – one short lived with a high biological component and one longer lived durable technical material product. These cases cover different product categories, different value creation archetypes and varying deployments of the four building blocks (see table 1 and 2).

3.2.1 Case 1 Bedding Plants: easyGrow™

Case 1 is bedding plants. Until 2014 the plants were grown using a media that was over 90% peat and packaged in virgin expanded polystyrene trays that could not be easily recycled or re-used. Peat is effectively a non-renewable resource and is recognised as an important carbon sink and contributor to biodiversity (Natural_England, 2010).

The company sells over 9 million packs of bedding plants per annum – equating to over 54 million plants - and has been considering a move away from peat and expanded polystyrene for many years. Progress was slow and difficult as the existing materials had good, tried-and-tested performance, and were comparatively low cost.

3.2.2 Case 2 Worktop: Infinite

The second product is a timber kitchen worktop that is a major part of the company's product range in all its operating companies. Currently the company's timber policy is applied to the worktop design. This requires that all components are certified with full chain of custody with either FSC (Forest Stewardship Council) or PEFC (Program for the Endorsement of Forest Certification). Timber is sourced globally. In response to this, the French operating division of the case company developed a worktop constructed from waste materials sourced from other parts of the business.

3.2.3 Case 3 Paving: Neo Eco

The case company is one of the largest suppliers of domestic paving in Europe. It sources materials globally including from many developing countries. The company works with the TFT Responsible Stone Programme[2], to improve ethical and

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[2] http://staging.tft-transparency.org/app/uploads/2015/10/About-the-TFT-Responsible-Stone-Programme.pdf

environmental standards in quarries and stone processing factories in developing countries. The company has designed a new product, Neo Eco, for the French Market with commercial release set for 2018 as an alternative to current stoneware products. This product is designed using waste materials from other industrial processes.

3.2.4 Case 4 Rental Power Tool: Tool Rental

As Europe's biggest home improvement retailer, the case company has significant market share in power tools. Several studies have suggested that on average they are used for just a few minutes every year and replaced on average every 5 years (EMF, 2012). This means that many of the tools take up space in customers' homes and are used rarely. Offering a tool rental service therefore would appear to be an attractive value proposition. Whilst tool rental is a well-established business model, delivering a retail tool hire within a store set-up that sells low price power tools is unusual. This is the challenge that Kingfisher has been contending for some time.

3.3 Data Collection Methods

Varied methods were used for data collection including questionnaires, short focused interviews and participant-observation.

The use of questionnaires in a case study increases the reliability of the research (Lage Junior & Godinho Filho, 2016). With such a large range of products and different supply chains, the company required a method of assessment that fulfilled a number of criteria including capacity to be applied to over 1000 products cost effectively. Commercial requirements were important so as to ensure the relationship between product design and customer value proposition was not lost: retailing a closed loop product that didn't sell would be considered commercial suicide. Three potential existing assessment methods were evaluated by the case study company, including life cycle analysis (LCA)(ISO_14040, 2006), cradle to cradle (C2C) (Braungart, McDonough, & Bollinger, 2007; Kumar & Putnam, 2008) and circularity indicators (Tuppen, 2016). Each was found to have to have merits but also significant drawbacks including the extent of data requirements which would be potentially prohibitive in terms of time and cost. The company therefore commissioned its own circularity scorecard which was designed in conjunction with external consultants (available upon request from the company). The scorecard method drew on a number of elements from the three methods previewed. It requests detailed information from the key Tier 1 suppliers against six impact areas including: material safety and sustainability, energy and carbon, product utility and function, ethical issues, and its measurement criteria and scoring system. Details are available through Kingfisher[3]. This data collection method is integrated with existing Kingfisher policies which enables the company to integrate and utilise existing supply chain data sets and assessments.

Direct participation-observation is a powerful way to study people and projects in a natural setting (Kawulich, 2005) and can provide a much better understanding of what has occurred or is happening than secondary data or retrospective methods (Bernard, 1994). It ensures validity and reliability of research (Barriball & While, 1994). One of the authors has a lead role within the case study company's closed loop programme, has oversight of all the cases presented and is immersed in the practice of bringing projects to market. Hence, the author has provided her own in-depth insights and reflections from several years practice and in turn sought further feedback from project leads of each case study. This helped us in understanding not only the cases but also how the learning from the four cases is continuing to influence future CLSC developments within the company Additional data from internal company documents

[3] http://www.kingfisher.com/sustainability/files/reports/cr_report_2016/2016_Sustainability_Report.pdf

and published reports offered scope for triangulation and validation of findings (Bouzon, Spricigo, Rodriguez, de Queiroz, & Cauchick Miguel, 2015; Silverman, 2005).

3.4 Analysis

Once a product or supply chain has been nominated the retail company provides the third party consultants with as much data and information as is available to undertake the analysis on an iterative basis. Two of the case examples, Easy Grow and Neo Eco, were analysed using data from the closed loop questionnaire and scorecard was presented back to the company's closed loop steering group to check accuracy and issues that may have been missed. This led to discussions of what the next steps will be. Additional wider research into internal and external reports and data was then undertaken. This led eventually to ways of assessing the product or supply chain as gold, silver or bronze, against a publicly available scoring guide, and identification of future innovation opportunities. See Appendix 1 for sample questions for one theme in the closed loop supply chain assessment questionnaire. In the case of the tool hire and kitchen worktop there was much less data available and a greater reliance on internal company documents and a narrative approach based on interviews with the project leads.

4. Findings

4.1 easyGrow™

The origins of easyGrow stemmed from customer surveys and feedback indicating that the polystyrene packaging was difficult to dispose of and also contributed to damage to plants which were difficult to extract from the casing. Up until 2013 the product had strong linear characteristics, peat was sourced from eastern Europe, and polystyrene packaging, labels and plants were all assembled at the UK based nursery before growing on (see Figure 1 dashed line). A member of the Company closed loop programme organized a supplier summit and identified two UK based growers to develop an alternative growing substrate and packaging design that utilised recycled materials and could be re-used in a closed loop (Figure 1 solid Line). This new product – easyGrow: is an illustration of a new CLSC relationship and collaboration.

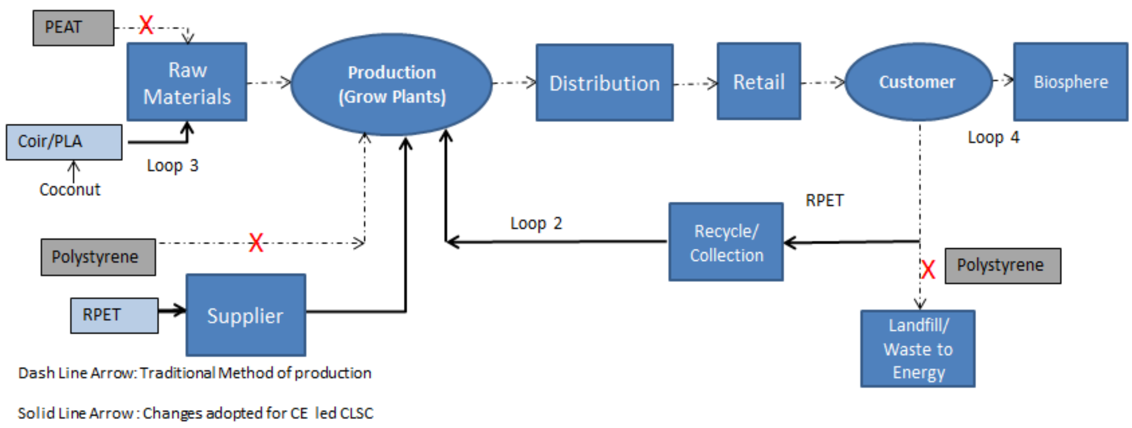

Figure 1. Closed Loop Supply Chain for easyGrow™

Coir, a by-product from coconut processing, was identified as the most effective peat free growing medium and suitable suppliers were found in Sri Lanka. This entailed re-design of key aspects of the product. Dried coir tablets were encased in a compostable PLA (Polylactic Acid) net. PLA, a biodegradable thermoplastic polymer made from plant starch, is similar to a teabag. It would allow plants to be planted directly into the soil and reduce damage to the plants whilst improving reuse options for the customer. The dried tablets reduce the weight of the product. The growers then hydrate these in the UK and insert a plug plant into a recycled, reusable, food grade polyethylene rPET (recycled polyethylene terephthalate) using single source feedstock, in a tray sourced from western Europe, and the plants are grown on before being distributed to stores. Chemicals used in the plant production vary by crop and time of year but a full list of approved chemicals used by the growers was supplied in response to data requests and used to check compliance with current and pending legislation, notably the REACH directive[4].

Corner stones of the easyGrow value proposition is that it should be priced no more expensively than the existing product, while external packaging would be placed in domestic plastic recycling systems and should be capable of re-processing as r-PET.

The product has been very successful with high levels of customer approval. Since 2014, easyGrow™ is now employed for all of its pack bedding plants. The product redesign has led to 97% of the product being from renewable (Coir) or secondary materials (rPET) with 99% reduction in non-renewable peat. An internal assessment study estimated an overall 20-40% carbon and energy reduction compared to the peat/polystyrene design, but noted that the coir required more water than peat to ensure an optimal growing performance. The review of chemicals used by the growers found no substance of 'Very High Concern' (against REACH) although several of the herbicides used by the grower are subject to ongoing regulatory scrutiny and at risk of future bans or restrictions, highlighting the importance of vigilance and a need for continuing innovation in pest control and material safety.

The shift to coir, PLA netting and rPET however raised a number of strategic and operational challenges: notably the switch in materials and packaging design increased overall materials costs making the product more expensive than its predecessor. However, the re-design meant a 30% smaller footprint which made the design cost neutral.

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[4] EC 1272/2008. Registration, Evaluation, Authorisation and Restriction of Chemicals (**REACH**) is a European Union regulation dated 18 December 2006. **REACH** addresses the production and use of chemical substances, and their potential impacts on both human health and the environment.

Secondly, the substitution of coir for peat has required identifying, assessing and developing new supply chain partners in Sri Lanka. The Tier 1 supplier of the Coir was able to identify the location of around 75% of the suppliers of the raw coir pith and fibre mills. 80% of the coconut husk from which the coir is made is purchased on open markets. Coir is not considered a scarce resource and the Sri Lanka coconut industry is well regulated. However, sourcing from a single country with a recent history of political conflict and civil war means that vigilance over future risk of supply is required. In contrast, there is no supply chain coordination or data on PLA nets from China and hence it has not been possible to audit or verify production processes, environmental impacts or working conditions.

The sourcing rPET also required identifying new partners for the packaging design. This was relatively straightforward and resulted in 22,500 cubic metres of polystyrene packaging per annum being diverted from the supply chain. Although the plant and coir can be composted by the customer, the only option for the tray currently available is for it to be reused by the customer as a seed propagator. The PLA module is designed to decompose in the soil but found to decompose very slowly, meaning that in terms of a circular economy biological material cycle the material choice and subsequent cascades are not aligned with product function.

The option of customers being able to take trays back to stores is currently being piloted, but a lack of local authority facilities and infrastructure to ensure the collection of uncontaminated rPET to feedback into the material cycle is proving problematic, as regulatory issues means that the tray cannot be treated in the same way as a PET food tray. The retailer is therefore reviewing alternative compostable materials working with partners to lobby for an improved recycling infrastructure for rPET trays.

4.2 Infinite

In the Kitchen product range, most components, including the worktops, are made from composite timber (often with some recycled wood content) with a laminate coating. The whole kitchen is typically replaced every 7-10 years due to changes in fashion, damage or wear but can last longer. Options for circular value creation via end of life re-use and materials cascades however are limited because of the use of treated composite timber.

Infinite was a product design promoted from the company's French operating division, Castorama. Its aim is to offer a premium product that incentivizes the customer to 'bring back' the worktop to a store so as to obtain a discount against a new or replacement worktop. The product redesign involved a new partnership with Certech, an independent chemistry centre, Veolia, a major global waste management company, and a composite wood manufacturer. The new material called ReMade is made completely from a composite of waste material, including wood and plastic waste from other business units within Kingfisher.

The new worktop was designed with a hollow core, reducing weight by 30% and therefore reducing its distribution impact. A laminate coating made from virgin material reduces any risks of food or human contact with the composite material. Infinite is designed in such a way as to be capable of being remanufactured into an 'as new' worktop (hence the name infinite) or other products such as timber decking on a closed loop cycle with minimal reduction in material quality. The design reduced the quantity of virgin timber per worktop, is cheaper than virgin hardwood, and reduced the amount of and costs of disposal of internal waste streams.

The launch of the product faced two key challenges. Firstly as a value proposition the work-top was priced alongside other premium worktops with more established customer acceptance. The lightness of the worktop whilst reduces transportation and handling costs, inadvertently it created the perception of a reduced quality compared to full timber options. Secondly, it was realised that with small volumes collection and returns would have to be facilitated by the retailer – it would not be feasible for collection and storage at public amenity sites. Had the reverse flows scaled up the company would have needed to invest in a range of new activities including customer service and collection, storage and handling and subsequent reprocessing and re-use of the product and materials.

Although the launch of Infinite was less successful than had been expected the organisational learning from the development of Infinite led to identification of new opportunities for the Remade material, which is now being deployed in other product categories where the weight of 'infinity' composite would be less of an issue, such as decking boards.

4.3 Neo Eco

The extraction and manufacture of stone paving is energy and resource intensive as well as hazardous and a source of wider environmental impact. Stone paving is also a highly durable long lasting product hence finding alternatives and ways to close the loop is challenging. Neo Eco is an external paving product created by Neo Eco recycling in France as an alternative to stoneware paving, thereby potentially reducing demand for virgin stone. The product design incorporates waste materials cascaded from other value chains, notably waste to energy plants and concrete from deconstruction sites sourced within 50km of the paving production site to minimize costs. The product comprises 80% approximately of waste materials and 20% by weight polyester resin of which 7% is styrene.

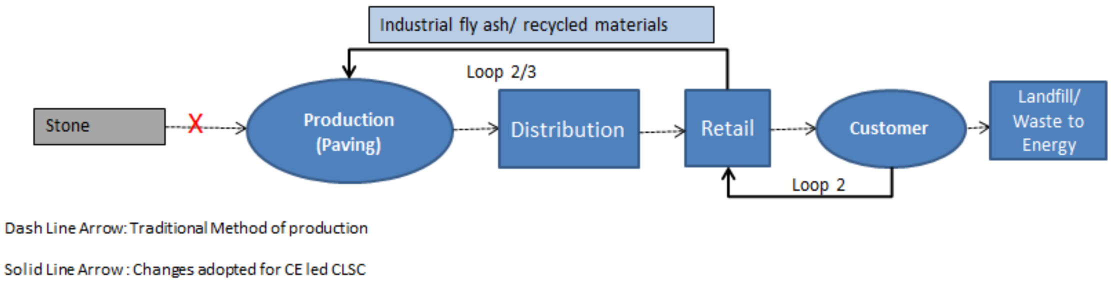

Figure 2. Closed loop supply chain initiative for Neo Eco

The business model includes a take back scheme for end of life returns which will be re-used in the production of new product. As the product is about to be launched the customer take up is not yet known.

A key challenge facing the launch of this product is that end of life collection at Municipal facilities in France is not yet available and therefore the operational planning for the reverse network is still under development.

A second key challenge is that whilst styrene is not prohibited in current EU Reach regulations it has been identified as a chemical that may become restricted in the future. Re-using bottom ash or concrete raises concerns about possible health effects of various chemicals hence rigorous procedures and control measures are required to ensure these are measured and monitored to comply with current and future regulatory requirements for human health and ecotoxicology risks. The circularity scorecard assessment identified that alternatives need to be explored and a full material health assessment of the component materials of the resin should be audited and assessed. Suppliers of the polyester resin are currently being audited in line with the case company's overarching supplier assessment requirements.

4.4 Tool Rental

There are many specialist tool hire companies operating as stand-alone businesses or as part of branch networks or wider merchants. In 2014, UK tool hire revenues topped £2bn. Most of these revenues relates to items that are expensive to purchase and where they are needed for short time periods. Power drills for the consumer market in contrast are relatively low cost, widely available items and hence a daily rental can equate to between 30-40% of the purchase price of an equivalent new drill.

In addition, power tools have a complex bill of materials and multi-tier supplier networks hence the ability to design a business model to combine rental and remanufacture is more difficult than with higher value OEM products.

The company has been running a successful tool rental proposition in their Polish operations, the first case study operating company to do so (Kingfisher, 2013, p. 13). The tool hire scheme has been operating since 2012 with around 4,000 tool rentals per annum. However, outside of Poland developments have been slower due to the different market dynamics and concerns about cannibalization of sales.

The success in Poland is due to several reasons. Firstly, there is a strong trade and tool repair tradition in Poland so the company has had an established in-store tool repair infrastructure in place for a number of years. The company repairs over 120,000 tools per annum which otherwise might have been discarded or repaired. This provided a good strategic fit between the requirements for rental and for repair and tactically made it much easier to route equipment through different re-use options (rebuild, repair, cannibalise for parts, recycle). Operationally the tool repair service had an established work flow procedure for maintenance and quality assurance making it relatively easy to piggy-back upon this established regime. Secondly, the repair service also offers added value services including workshop areas for DIY projects and sources of information and advice on products and projects. This has led to experiments outside of Poland to overcome cultural barriers to ‘tool-hire’.

The company is piloting stores with space where customers can share information, attend home improvement classes, use specialist machinery and tools to get their jobs done, identify wood cutting services and installation services for doors and windows, and use a platform enabling them to connect with people who can help with their home improvement projects.

The four cases are a small sample from a larger circular economy inspired closed loop programme targeting 1000 products and 10 major supply chains by 2020. The case study company admit that they have embarked on a journey. They expect to have successes but also to take risks which assist them in understanding the challenges in closing loops upstream and downstream, while also building capability and competencies to manage complex and difficult issues and achieve future competitive advantage.

5. Discussion

The four cases are linked by virtue of being from the same case company, and illustrate different value archetypes, from different operating units at different points in time. Table 2 summarises the key findings from the four case studies showing the classification of value creation (archetype as stated in section 2 above), an assessment of the value created, changes related to the four building blocks from Table 1 and the key challenges faced. The four cases highlight the following key points:

The four cases show that circualr economy and closed loop actions can be initiated and developed in a number of ways with varying degrees of complexity. Easy Grow involves major changes in materials, suppliers, and product design with new and demanding supply chain collaboration. Neo Eco, on the other hand, involved sourcing and manufacturing products from waste materials locally and working with material flows from other industrial activities with material safety concerns. Across the four examples different forms of value for different stakeholders can be identified – some of them quantified, others not (or commercially sensitive and hence not publishable). Categories of value include benefits to customers (convenience, take back options, rental versus ownership, additional services), benefits to the firm such as internalization of costs (e.g. using internal waste materials for new products), reduced reliance on virgin materials (peat, timber, stone, plastics, new products) and wider societal benefits including, as noted, reduced reliance on virgin materials and/or non-renewable resources. Changes to materials, product design or suppliers leads to new requirements and challenges for audit. EasyGrow for example required assessment of labour conditions in China which proved impossible to audit fully. Perhaps most importantly the four cases also varied in terms of commercial viability and market uptake: one was highly successful, one most successful, one partly successful and one to be launched.

In three cases (Easy Grow, Neo Eco and Infinity) product design was a key building block in the new value proposition. In each of these cases, the incorporation of materials otherwise defined or categorised as waste from other value chains is not unproblematic in terms of material safety issues (Neo Eco, Infinity), cost (Coir), other resource inputs (water) or future re-use pathways (PLA netting rPET packaging) making the assessment of value more complex. Even in a successful case such as EasyGrow, the balance of material and resource benefits needs to be carefully identified and measured to avoid unintended consequences and subsequent negative externalities (e.g Coir and water consumption).

The recovery of product in the four case examples illustrated different challenges to the design and management of cost effective reverse networks. Central to this is customer willingness to return product. Neo Eco and Infinite sought to address this challenge by building incentives to return product at end of use phase, although how effective this has been in practice has not been assessed, whilst the tool hire model in Poland operates a traditional contractual hire period providing control over forecasting, scheduling returns and servicing. The challenge for Infinite and Neo Eco is that these are relatively long lived goods with low residual value or incentive for customers to return. This presents the company with challenges around forecasting return rates, contamination, storage and remanufacturing processes, and generating more complex operational requirements in terms of staffing, infrastructure, in-store design form and function. These two examples and the limited success of tool hire outside Poland runs counter to the view of Choi et al. (2013) that closed loop propositions might be more successful in retail due to proximity to the customer although, as the tool hire example showed, circular value proposition and business models require dynamic innovation and adaptation to search for different forms of value creation.

Extending the scope of a value chain to include materials sourcing to collection, segregation, storage and re-use inevitably requires new arrangements and incentives to share and distribute costs and value. As highlighted above the lack of public collections systems for packaging (Easy Grow) or product (Neo Eco and Infinity) have proven a major challenge, requiring in-store collection, whilst the collection and reprocessing of packaging or product, even those with recycled content, often raises complex regulatory issues relating to chemical safety or food regulations. Failure to anticipate and design out such issues creates the potential to increase costs and risks that possibly outweigh value to the business or customer.

The cases illustrate the enabling role and importance of leveraging key organisational characteristics and capabilities. In this case internal training to support the development of an innovation culture to ‘fail fast’ and develop capabilities and capacities to learn from success and failure have been put in place. These build on long established supply chain audit processes and environmental, product certification, ethical and risk assessment tools. This in turn highlights a more general point about information management and the integration of material data with supply chain management databases and procurement systems. Such integration is necessary to provide visibility and ability to track product, components and materials flows as part of a continuous innovation cycle and forecast and the value and operational requirements of returning assets. This prior investment provides the tools and agility to be able to learn from each project and be better placed to assess further supply chains and closed loop product propositions.

Table 2. Key Findings: Value Creation from CE led CLSC

Case	Primary Value creation Archetype	Customer Value proposition	Design	Business Model	Reverse Network	Enablers	Circular Value created	Key challenges
EasyGrow	Value Loop 2, 3 and 4	Convenience , Fewer damaged plants Less problematic packaging Equivalent price	New renewable growing substrate, Smaller packaging with recycled content	No change	New global suppliers New collaboration with growers Disposal of packaging	Strategic leadership for CE enabled CLSC program , systems and training programme Chemical Hazards Legislation Circularity scorecard	Improved customer experience and reduced material waste Cost neutral Improved material safety, compliance and anticipation of regulation e.g REACH 90% reduction in non-renewable resource Reduced carbon footprint per plant	New international supply chain set and complex new audit requirements. Lack of collection systems to segregate rPET packaging Biodegradability of new product component
Infinite	Value Loop 2, 3	Returnable product at end of life with discounts on replacement product Lighter product	Design for remanufacture Lightweight design using waste materials	Sales model with incentives to return product to store	Low returns and lack of pubic collection infrastructure Returns disposition – whether to remanufacture, re-use or recycling reprocessing	Strategic leadership for CE enabled CLSC programme, systems and training programme Chemical Hazards Legislation	Weak sales hence product withdrawn but led to other products being developed Alternative higher value uses for otherwise waste materials Alternative to virgin timber or stone products	Customer acceptance and product take up Prospective low and variable volume of product return
Neo Eco	Value Loop 2, 3	Returnable product at end of life with discounts on replacement product	Replace stone with alternative waste materials New	Sales model with incentives to return product to store	Collection systems and product Returns disposition – whether to remanufacture, re-use or recycling	Strategic leadership for CE enabled CLSC programme, systems and training programme Circularity scorecard	Not yet launched but designed as: *Alternative to virgin stone* *Capable of remanufacture*	Prospective key challenges Materials safety Collection and storage of returned product

			suppliers New design to enable materials re-use		reprocessing		Thereby reducing demand for virgin materials	
Power tool hire	Value Loop 1	Access to wide range of tools with reduce capital outlay	No change to core product(s)	Rental	Staffing, equipment storage, repair and maintenance planning	National culture of tool rental and repair	Customer access to tools and added value services Higher material productivity and cost per job than ownership model	Competition from sale of low priced tools Replication of model re cultural issues and traditions around hire and repair

Three of these cases – Easy Grow, Infinity and Neo Eco - were initiated with the goal of integrating value to the customers within the principles of the circular economy, rather than environmental and social values being seen as by-products as is often the case in closed loop analysis (Schenkel, et al. 2015b). To achieve this typically requires that the four building blocks need to be managed and reconfigured simultaneously by key agents to deliver the highest value (Hopkinson, Zils and Hawkins 2014). As has been shown however, this is complex and even in successful commercial cases there can be many issues left to be resolved through further iteration and innovation.

There are many areas for future research in CE led CLSC. Those considered most important as a follow on from this study are as follows. Souza (2013) has previously called for more empirical research documenting cost structures including acquisition, collection and re-use as well as the overall market and customer response to re-used products. This remains the case although obtaining such cost data for publication is commercially sensitive and difficulties in obtaining it should not to be underestimated. The relationship and feedback loop between recovery activities and product design remains under explored and more case examples of successful retail-customer collection, recovery and reprocessing systems are needed. The four cases examined hint at a number of possible social benefits but require further codification and clarification as to how such initiatives generate social value. A number of authors (e.g. Evans 2009) have pointed to the need for research at a wider systems level that would analyse overall system performance to support the design of circular value propositions and supply chains.

6. Conclusion

This study demonstrates that value creation opportunities from closing loops are varied

and can have different meanings for technical and biological materials. The cases vary in scale and scope, commercial success and categories of value creation –
the firm, the customer or wider social and environmental value creation - although none of these are necessarily easy to achieve, measure or quantify.

The view that creating value from circular supply chain design might be easier in FMCG is not borne out by several of these cases and, regardless of the sector, the interaction between product design and customer response as highlighted by Souza (2013) together with business model and reverse network management all need to be addressed to achieve commercial viability. Whilst the cases are specific to a single company there are wider lessons and conclusions that can be drawn from this study in order to implement successful circular supply chains.

Firstly, businesses need to develop competencies to integrate product design, business model innovation and reverse network management to bring about product re-use, cascading and recycling to support the preservation and regeneration of natural capital. To achieve this, greater attention and awareness around the purity and safety of material flows in future cycles is required. This requires capabilities for ensuring full chain of custody and material passport.

Secondly, success in business model innovation requires the ability to spot opportunities for new value propositions, value creation (cost reduction, revenue growth, new sales, retention of customers, new services) across a roster of business model types (rental, performance, product service systems, resale). Developing opportunities requires an ability to create structured business cases and business modelling to demonstrate the superior financial value to the customer and the business. As can be seen in the four cases, the level of data available on each case varies and although there is restriction due to commercial sensitivity, the more business case evidence that can be provided to show and validate a positive business case, such as EasyGrow, the more confidence there will be in business experimentation and innovation. Lessons learnt from Poland also demonstrate that narrowly defined 'business models' can be adapted to develop wide value propositions around product-service systems to redefine the firm-customer relationship at a much wider level than a simple product hire model. This requires innovation, potentially far more disruptive than simpler product redesign.

Thirdly, the costs of collection, treatment, segregation of products, components and materials is one of the biggest barriers to creating circular inspired closed loops. Anticipating and designing these reverse networks and developing capabilities are therefore critical. Retailer-led collection systems are notoriously difficult to co-ordinate; they require a combination of incentives to return goods, plus convenience and the ability to transfer to the next stage of recovery cost effectively. This is challenging for bulky goods hence forms a key area for future research and innovation.

Finally, as a company increases both the scope and scale of closed loop activities there are increases in the requirements for assessment, audit and relations to pre-existing supply chain and procurement systems, customer data, audit and assessment tools and data sources. This in turn requires new competencies and capabilities to integrate forward and reverse flows to manage, track, and assess reverse product and material flows and ultimately optimise value loops to enable products and materials to circulate at their highest value for the longest period.

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Appendix 1

Close Loop Supply Chain Questionnaire

All	Reutilised materials	What % of the product is made from: a) Biological material b) Recycled content c) Reused content?
All	Supply chain map	Map your supply chain for all components as far as possible, including locations where known. Provide details and location of final production site as a minimum
All	Raw materials source	Can the supply chain be mapped to raw material source for minimum one material constituting 10% of the total product by weight? (increasing to 25% of total product by weight for gold level)
All	Environmental risk	Are you involved in any material specific industry scheme? E.g. BCI, RSG, FSC
Up-stream	Manufacturing waste	Identify the waste generated during the final manufacturing process (give tonnage where available)
		What % of this waste is: a) Composted b) Recycled c) Reused?
		Is there a waste management plan in places at the final production site?
All	Packaging	Identify % of primary packaging which is: a) Recycled b) Recyclable
		Identify % of secondary packaging which is: a) Recycled b) Recyclable
All	End of life	Have municipal/kerbside waste streams been identified that the product could go into?; please give details
		What proportion of material is fed back into circulation at the end of life through either: - Biodegradability - Recycling - Remanufacture - Reuse? (industry standard figures will be used if there is no take-back scheme)